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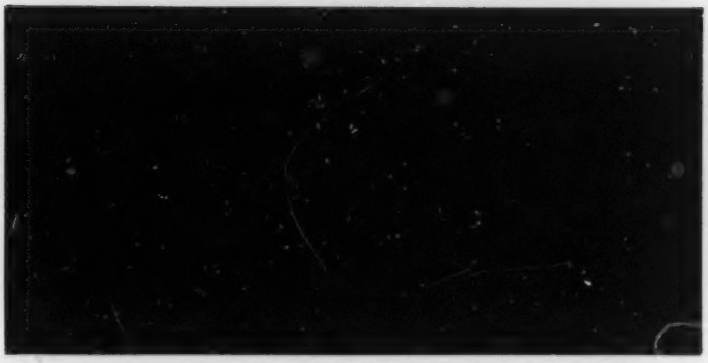

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# THE BANDWAGON ONCE MORE: VOCATIONAL PREPARATION FOR HIGH-TECH OCCUPATIONS

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## Abstract

Vocational education has been no exception to the current preoccupation with the new technologies. Particularly at the postsecondary level, educators are expanding high-tech programs and calling for a further orientation of programs around new technological developments. In one sense this effort is justified because evidence from Texas shows that high-tech sectors do hire large numbers of middle-level technicians who receive a substantial economic return to postsecondary training; on the other hand, the number of middle-level, high-tech jobs that will be created in the next decades will be low. In addition, postsecondary enrollments have shifted rather dramatically toward high-tech programs. Despite the novelty of high technology, several continuities with the history of vocational education have emerged: the overblown promise of vocational education as a panacea, the problem of keeping up with technological developments, the dilemma of providing too-specific training, and the basic confusion over egalitarian goals. These continuities suggest potential problems that will have to be addressed directly in order to avoid the detrimental consequences of the vocational imperative.



## Acknowledgments

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The technological determinism that suffuses the United States tends to identify new technologies as the generators of economic and social progress. The conventional depiction of the Industrial Revolution as a series of technical developments, increasing general productivity and the standard of living as well as transforming all social institutions, has been repeated for other changes, especially the development of the railroad in the nineteenth century, the development of electric power and the automobile in the early twentieth century, and now the development of micro-electronics.[1] A corollary of technological determinism is the search for technical solutions to social and economic problems, as in the recent infatuation with high technology as a way of increasing productivity, reducing unemployment, rescuing declining regions, and promoting our international competitiveness.

In education, there has been a tendency to view schooling as a panacea for social and economic problems,[2] similar to technological determinism in promoting for solutions that have little to do with the causes of problems. The current concern with the ways schools should be transformed to promote high-tech development therefore combines two powerful strands of thought about social and economic improvement. This combination is in some ways more potent than each individual strand, because it allows educators to claim the rhetoric of economic development for the schools, and gives the schools a centrality and "relevance" that can no longer be claimed for moral and intellectual development. Small wonder, then, that educators cannot resist jumping on the high-tech bandwagon.

Much of the debate over the role of education in high technology has emphasized the shortages of M.A.s and Ph.D.s, and the need in elementary and secondary education for improved math and science instruction. Not surprisingly, however, vocational education has also been affected by the current preoccupation with training for high-tech occupations. Vocational programs provide special opportunities to examine the changes within the schooling system, because they are tied more explicitly to economic imperatives and are less constrained by conceptions of academic or liberal education.

Within vocational education, the most important developments are now taking place at the post-secondary level, especially within community colleges. In 1980-1981 post-secondary programs accounted for perhaps two-fifths of all vocational enrollments.[3] The importance of post-secondary programs, rather than the high-school programs that have always been the heart of vocational education, may be even greater than these numbers indicate, since a great deal of secondary vocational enrollment is really avocational (in automobile repair courses, homemaking, and typing). In addition, there is now substantial evidence that the rate of return to secondary vocational education over alternative curricula is generally zero, while the evidence on post-secondary vocational programs is at least mixed.[4] While high-school vocational ed has increasingly come under attack, post-secondary programs have been the most robust educational sector of the past decade.

The evolution of the community college is itself an arresting development. Over the past two decades community colleges grew faster than any other level of schooling. Between 1970 and 1980 enrollments in two-year institutions grew by 114%, while the rest of higher education grew by a modest 19%; by 1982 community colleges accounted for 38% of enrollments in higher education.[5] (Even during the 1960s, community colleges increased by 261%, compared to 89% for four-year institutions.) As the community college expanded, its central purpose changed from a predominantly academic institution leading to a four-year college to a vocational institution with terminal degree and certificate programs.[6] Currently, there is substantial agreement that two-year institutions have become predominantly vocational rather than academic, although the data to substantiate this trend remain elusive.[7]

Other levels of American education provide close parallels to the growth of the community colleges during the 1960s and 1970s.[8] Between 1890 and 1920 high school enrollments grew rapidly, and the high school became (after considerable debate) increasingly vocational rather than academic--both in the sense that explicitly vocational curricula developed, and in the more general sense that educators promoted the high school as a way to get jobs. The expansion of four-year institutions in the post-World War II period followed similar patterns, with a shift towards more explicitly vocational curricula

like business, engineering, and nursing. The developments in the community colleges are therefore part of a larger process, affecting all levels of the educational system, by which schooling has become increasingly vocationalized.

Given the vocational roles of the community colleges and the attraction of high-tech development, it is not surprising to see post-secondary vocational education turning increasingly to preparation for high-tech occupations. The journal of the American Association of Community and Junior Colleges (AACJC) is filled with stories of programs being developed in exotic specialties like robotics, laser technology, and computer assisted drafting (aided with grants of equipment from IBM), as well as more "conventional" courses in computers and electronics; high rates of growth in energy-related technologies have also been reported.[9] Many of these developments have latched onto the rhetoric of economic development that has become common for the rest of education; the robotics program at the Oakland (Michigan) Community College has been justified as contributing to "Michigan's salvation" by replacing jobs lost in the auto industry,[10] and the president of a community college in an area of high unemployment declared that "The development of high technology programs represented our very best hope, not only of attracting new industry to our area, but for helping existing industry compete and prosper".[11]

The rhetoric and plans of community colleges have become equally obsessed with high-tech developments. The AACJC's analogue to the report of the National Commission on Excellence in Education, a "concept paper" entitled "Putting America Back to Work", directed special attention to the "current and predicted skill shortage areas of employment opportunities, particularly in high-technology occupations" like computer analysts and programmers, computer software engineers, and electronic technologists.[12] The conventional wisdom that the United States is moving from an industrial and service economy to an "information economy", with a predominance of "information employees" requiring more training and high-tech skills, has been cited as a special challenge and opportunity for community colleges.[13]

Just as every other level of education has begun to search for new sources of funds to support high-tech education, community colleges have

developed initiatives for new federal programs and for business-education cooperation. The Governmental Relations Commission of the AACJC recommended new federal initiatives for "human resource development", defined as "retraining employed workers in high technology and service occupations; upgrading workers for new technologies; strengthening basic skills and technological knowledge of military recruits; and improving workers' productivity to offer an improved competitive posture".[14] The AACJC's Council for Occupational Education has developed a high-technology technician training act which provides tax incentives for private corporations to develop partnerships with community colleges, as a way of training and upgrading technicians.[15] The rhetoric of "partnerships" with business and industry is ubiquitous; partnerships are both the means of securing hardware and instructors in rapidly-developing high tech fields and ways of providing specific training for--and thus securing jobs in--new and expanding companies.[16]

All the themes and slogans that have preoccupied the rest of the educational system have influenced developments in post-secondary vocational education as well. At every level, the same questions apply: Is the current infatuation with education for high-tech occupations reasonable and justified? Will graduates of these programs find well-paid employment in their fields of training, or will programs in post-secondary high tech areas follow the common pattern of other voc ed programs, providing little economic advantage to their students? Above all, does the dawning of high tech mean a real transformation in schooling, or a continuation of older patterns?

In this paper, I will first examine some aspects of the demand for high tech voc ed, by using data on technician-level employment to examine the truth of several conventions about high-tech occupations. I will then look at the supply of students in post-secondary voc ed programs, to see how important high-tech has been in the expansion and development of post-secondary institutions. Finally, I will examine some powerful continuities of high-tech vocational education with the history of vocational education, as a way of identifying potential pitfalls.

## Patterns of Demand for High-Tech Vocational Education:

## Evidence from Texas

Community college advocates have argued that their institutions are most appropriate for imparting "middle-level" skills. They have offered a simple explanation for growth in post-secondary vocational education: jobs requiring middle-level skills have grown faster than other jobs, and the skills for these job are more appropriately learned in two-year colleges than in the high school or in four-year institutions.[17] These middle-level occupations include a large number of technicians, paraprofessionals, semi-professionals, foremen, and skilled clerical and craft workers. One description of these middle-level occupations includes the following characteristics:

1. They require training beyond the high school level;
2. They require some theoretical knowledge of mathematics and science equal to the first year or two of a professional program;
3. They require training in the development of manipulative skills for using delicate and precise laboratory instruments and equipment;
4. They often require that a person have personality characteristics which allow him to understand human behavior, especially if he is employed in a supervisory position or in a social-service or human-relations occupation;
5. They train students as assistants to professional workers or administrative officials.[18]

Often, the growth of such occupations has been credited to technological developments, with computer-related jobs and health technologies given as common examples of new and expanding occupations generated by technical advances. In this conventional view, occupational demand due to technical change leads directly to increased enrollment, with the implication that community college students then obtain jobs in the areas for which they have been trained.

However, two conventional wisdoms imply that high-tech sectors may not increase the demand for the technicians requiring the "middle-level" skill, associated with community colleges.[19] The first holds that technological developments generate jobs with higher skills, requiring additional schooling and resulting in higher pay and better working conditions; the usual implication is that high tech sectors increase the demand for college and

graduate education. The second convention--developed partly in reaction to the first--is that high-tech sectors have a bi-modal occuptional distribution, dominated at one end by highly-trained professionals with college or post-graduate degrees, and at the other end by low-skilled assemblers with little training. The existence of a bi-modal distribution has been used to puncture the claim that high-tech occupations are all highly-skilled, well-paid, and offer good working conditions. For education, the implication is again that the real demand will be for individuals at the B.A. level and above, two-year institutions are irrelevant except to insure a large pool of individuals having science and math prerequisites for advanced programs. If either of these conventions is correct, then the benefits of post-secondary voc ed programs for high-tech occupations may be negligible, because both of them imply relatively little demand for middle-level training.

There are two sources of data relevant to these claims: 1980 census data, which are the more detailed but also more difficult and expensive to use; and the Bureau of Labor Statistics National Industry-Occupation Matrix, with data for 1970, 1978, and projections to 1980. Table 1 presents 1980 Census data on the employment of four different categories of workers in high-tech and conventional manufacturing sectors, by level of schooling, for the state of Texas.[20] They show quite clearly that the occupational distribution of high-tech manufacturing is <u>not</u> bi-modal. Middle-level occupations, defined as technicians, are more prevalent in high tech manufacturing, since 15.1% of employment in high-tech manufacturing is in technician positions compared to 6.5% in conventional manufacturing. Furthermore, technicians in high-tech sectors tend to have more education, since 41.3% have some college and 18.4% have a B.A. or more, compared to 28.4% and 10.8% in conventional manufacturing. (Professionals and managers also tend to have more education in high-tech manufacturing, since 64.7% have a B.A. or over, compared to 47.9% in conventional manufacturing; however, clerical workers and assemblers in high-tech sectors have less education than their counterparts in conventional manufacturing.) If we consider "middle-level" occupations as those positions filled by individuals with one to three years of college, again there are relatively more of these positions in high-tech sectors--25.4% of total employment, versus 20% in conventional manufacturing, with proportionately

more of these "middle-skilled" individuals in professional, managerial, and technician positions rather than assembler and "other" occupations. These data support the contention that high-tech sectors do have somewhat more middle-level positions and generally require more education--both in professional and technical positions, and overall--compared to conventional manufacturing.

Corroboration of these patterns in Texas comes from the BLS Industry-Occupation Matrix. Table 2 gives the fraction of employment in a variety of high-tech sectors (using the "Massachusetts" definition again) employed as technicians and as computer specialists. Compared to employment in all sectors, high-tech sectors hire more technicians and more computer specialists (except for watches and clockwork and miscellaneous transportation industries). Furthermore, the projected growth in the proportion of technicians between 1978 and 1990 is higher in most of these sectors (though in most of them the proportion of computer specialists will decrease). Therefore, the claim that high tech industries have no skilled "middle" in their occupational distributions is again disproven.

The income distribution in high-tech manufacturing also fails to display any evidence of bi-modality. Figure 1 depicts the income distributions in high-tech and conventional manufacturing in Texas. The high-tech distribution has a slightly higher fraction of the highest-paid individuals, but otherwise there is no tendency for these two distributions to be radically different, and no support for the contention that the middle of the income distribution is eliminated by the rise of high-tech sectors.

The income distribution is important to education because it influences the rate of return to different levels of schooling. If there is no middle to the distribution of income, then it is more likely that there will be substantial returns to high levels of schooling, with lower or zero returns to moderate levels of education--the levels of education associated with post-secondary vocational education. Thus, the conclusion that earnings in high-tech sectors follow a conventional distribution suggests that returns to moderate skill levels may be about the same in high-tech and conventional

Table 1

OCCUPATIONAL COMPOSITION OF HIGH-TECH
AND STANDARD MANUFACTURING IN TEXAS, 1980

High-Tech Manufacturing

| Years of Education | Professionals and Managers | Technicians | Clerical | Assembler | Other | Total |
|---|---|---|---|---|---|---|
| 1-12 | 7.9% | 12.7% | 15.5% | 45.8% | 18.1% | |
| | 13.9 | 40.3 | 57.5 | 72.8 | 58.9 | 47.9 |
| 13-15 | 22.8 | 24.7 | 15.8 | 23.9 | 12.8 | |
| | 21.4 | 41.3 | 31.1 | 20.1 | 22.1 | 25.4 |
| 16 | 60.1 | 10.8 | 7.2 | 9.4 | 12.5 | |
| | 32.5 | 10.4 | 8.2 | 4.6 | 12.5 | 14.6 |
| 17+ | 72.1 | 10.1 | 3.5 | 6.3 | 8.0 | |
| | 32.2 | 8.0 | 3.3 | 2.5 | 6.6 | 12.1 |
| Total | 27. 1 | 15.1 | 12.9 | 30.2 | 14.7 | 100.0 |

Standard Manufacturing

| | | | | | | |
|---|---|---|---|---|---|---|
| 1-12 | 5.6 | 5.9 | 11.4 | 53.0 | 24.0 | |
| | 25.6 | 60.7 | 62.9 | 80.5 | 73.5 | 67.4 |
| 13-15 | 19.5 | 9.2 | 17.4 | 34.8 | 19.0 | |
| | 26.5 | 28.4 | 28.5 | 15.7 | 17.3 | 20.0 |
| 16 | 52.6 | 6.0 | 9.1 | 14.8 | 17.6 | |
| | 29.7 | 7.7 | 6.2 | 2.8 | 6.7 | 8.4 |
| 17+ | 64.0 | 4.9 | 7.2 | 10.8 | 13.1 | |
| | 18.2 | 3.2 | 2.5 | 1.0 | 2.5 | 4.2 |
| Total | 14.8 | 6.5 | 12.3 | 44.4 | 22.0 | 100.0 |

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The upper figure of each cell is the row percent; the lower figure is the column percent.

Source: John Campbell and Susan Goodman, High Technology Employment in Texas: A Labor Market Profile (Austin: Bureau of Business Research, The University of Texas at Austin, in process).

Table 2

PROPORTION OF EMPLOYMENT IN MIDDLE-LEVEL SKILLED OCCUPATIONS IN HIGH TECH-SECTORS

| | All Industries | | Ordnance | | Office, Accounting Machines | | Electric Computing | | Electrical Machinery | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 |
| Technicians | 1.26% | 1.34% | 5.00% | 5.51% | 3.96% | 4.37% | 7.39% | 8.12% | 4.92% | 4.84% |
| Computer Specialists | .46 | .50 | 2.38 | 2.28 | 3.34 | 2.75 | 13.69 | 11.73 | 1.04 | .88 |

| | Communication Equipment | | Professional Scientific Instruments | | Scientific Instruments | | Optical and Health Supplies | | Photo Equipment | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 |
| Technicians | 6.27% | 7.59% | 4.72% | 4.75% | 5.87% | 6.08% | 5.52% | 5.38% | 5.60% | 5.32% |
| Computer Specialists | 1.49 | 1.60 | .97 | .89 | 1.06 | .99 | .61 | .56 | 1.53 | 1.39 |

| | Watches and Clockwork | | Miscellaneous Transportation | | Drugs and Medicines | | Metal-working* Machinery | | Other Electrical* Machinery | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 | 1978 | 1990 |
| Technicians | 1.23% | .88% | 1.37% | 1.51% | 6.48% | 6.18% | 2.79% | 3.27% | 4.76% | 4.13% |
| Computer Specialists | .34 | .27 | .21 | .25 | 1.11 | 1.05 | .44 | .39 | .91 | .65 |

*Not a high-tech sector according to the Massachusetts definition.

Source: Bureau of Labor Statistics, The National Industry-Occupation Employment Matrix, 1970, 1978, and Projected 1990, Bulletin 2086, April 1981, Vol. I, Table 1.

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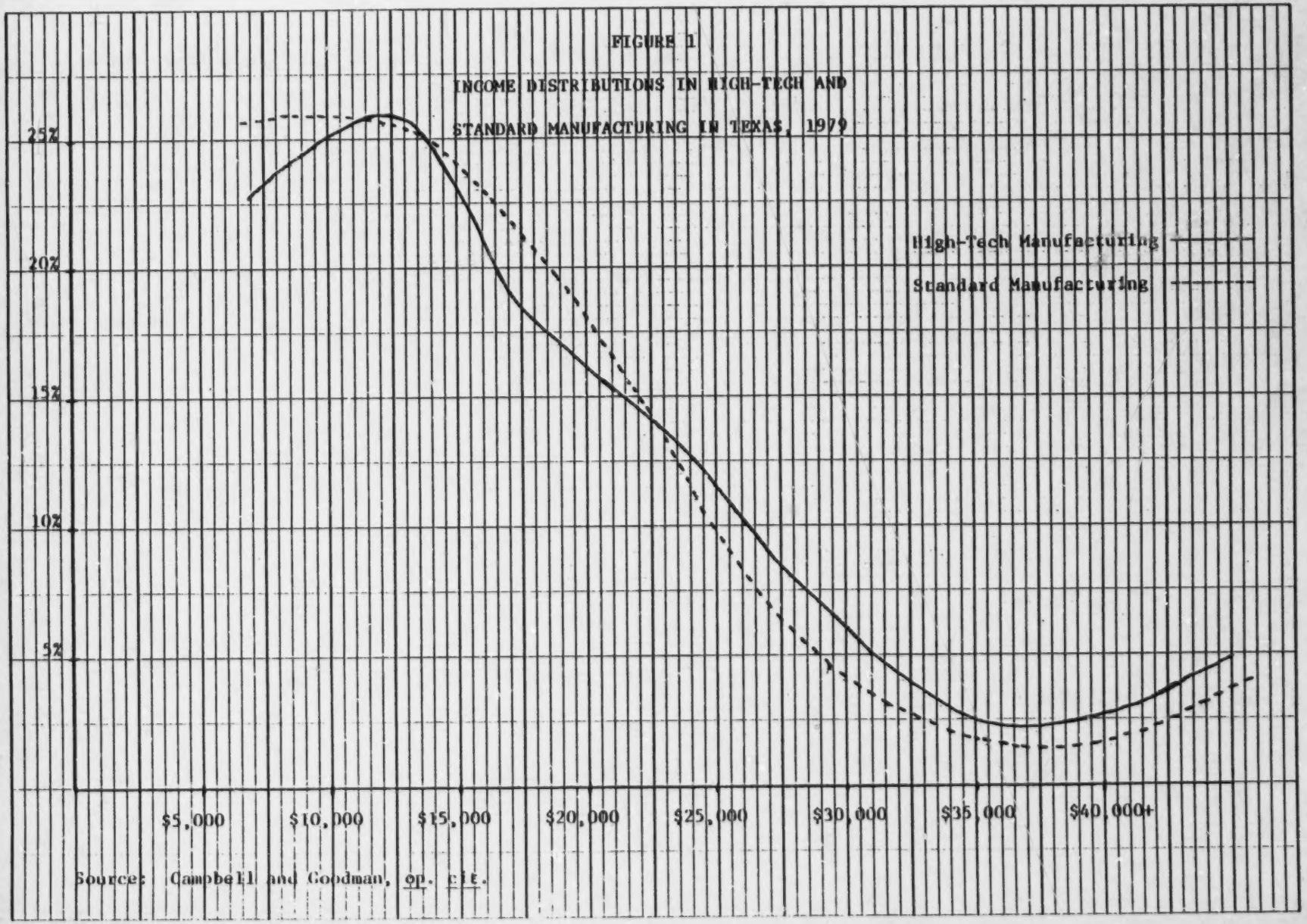
FIGURE 1

INCOME DISTRIBUTIONS IN HIGH-TECH AND STANDARD MANUFACTURING IN TEXAS, 1979




Source: Campbell and Goodman, op. cit.

Table 3

INCOME FUNCTIONS BY SECTOR FOR TEXAS, 1979

| | Coefficients of Independent Variables: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Post-Secondary | College | Graduate | Male | Black | Hispanic | Log Age | Work 75 | $R^2$ |
| 1. High-Tech Manufacturing | .157 | .419 | .517 | .412 | -.116 | -.195 | .369 | .178 | .55 |
| a. Electrical Machinery | .161 | .422 | .539 | .407 | -.125 | -.180 | .374 | .166 | .55 |
| b. Office Machines | .096 | .353 | .393 | .467 | .013 | -.178 | .498 | .241 | .43 |
| c. Computing Equipment | .184 | .430 | .462 | .411 | -.085 | -.248 | .465 | .239 | .55 |
| d. Communication Equipment | .060 | .298 | .406 | .442 | -.117 | -.159 | .433 | .143 | .57 |
| 2. Standard Manufacturing | .163 | .358 | .428 | .463 | -.186 | -.255 | .253 | .187 | .41 |
| a. Aircraft and Parts | .135 | .326 | .411 | .312 | -.137 | -.199 | .399 | .147 | .44 |
| b. Food Products | .173 | .390 | .495 | .369 | -.236 | -.272 | .208 | .201 | .36 |
| c. Non-electrical Machinery | .144 | .327 | .435 | .445 | -.124 | -.196 | .285 | .196 | .36 |
| d. Metal Products | .138 | .345 | .421 | .427 | -.210 | -.240 | .271 | .196 | .33 |
| 3. Computer and Data Processing | .068 | .293 | .329 | .396 | -.200 | -.083 | .560 | .206 | .46 |
| 4. Petrochemical Manufacturing | .163 | .358 | .428 | .463 | -.186 | -.255 | .253 | .187 | .41 |
| a. Oil and Gas Extraction | .110 | .391 | .499 | .419 | -.222 | -.187 | .345 | .198 | .43 |
| b. Petroleum Refining | .095 | .358 | .483 | .449 | -.090 | -.118 | .275 | .191 | .40 |
| c. Chemicals | .151 | .322 | .445 | .441 | -.170 | -.169 | .259 | .204 | .39 |
| 5. Retail Trade | .117 | .341 | .335 | .421 | -.188 | -.206 | .192 | .228 | .34 |

The dependent variable is the log of income. Post-secondary, College, and Graduate are dummy variables for those with 13-15, 16, and 17+ years of schooling; Male, Black and Hispanic are dummies; Work 75 is a dummy for those who were employed in 1975. Because of large sample sizes, all coefficients are highly significant.

Source: Campbell and Goodman, op. cit.

sectors. Table 3 presents the results of estimating income functions for different sectors of the Texas economy, and confirms this hypothesis: the returns to one to three years of college are almost exactly the same in high-tech and standard manufacturing (.157 and .163), although the returns to a B.A. degree and to post-graduate education are greater in high-tech employment. (There are substantial variations within each of these broad categories; for example, computing equipment has a return in post-secondary education three times the return to communication equipment.) Of course, returns to one to three years of schooling do not necessarily reflect returns to community college programs, but they do suggest that opportunities for post-secondary graduates are not lacking.

These results suggest that any fears about the lack of employment for "middle-level" skill training in high-tech sectors are unfounded, at least in Texas.[21] In this case, the demand for post-secondary education will be determined by the projected growth rates of high-tech sectors and of high-tech occupations suitable for vocational programs. Here the evidence is clear: although the growth rates of high-tech sectors and occupations will probably be relatively high, the numbers of positions created will be rather small.[22] Table 4 presents data on several middle-level, high-tech occupations, taken from the Bureau of Labor Statistics projections to 1995. While the growth rates in these occupations will be high relative to all occupations, the numbers of jobs created in these occupations will equal only about 1,431,000--about 5.6% of the total 25,600,000 jobs that will be created during this period.

The evidence suggests an equivocal conclusion about the demand for middle-level, high-tech positions. The view that high-tech sectors have no substantial demand for middle-level positions seems to be incorrect; therefore, there is some real future for high-tech voc ed. On the other hand, the numbers of such jobs that will be created is now and will continue to be a small proportion of overall job growth, despite high growth rates. The danger is that educators, like the rest of the country, may be easily attracted to high growth rates and so jump on the high-tech bandwagon, ignoring the fact that most of the jobs are likely to be in other, less glamorous areas.

Table 4

EMPLOYMENT IN SELECTED MIDDLE-LEVEL HIGH-TECH OCCUPATIONS, 1982-1995

| | Employment (In Thousands) | | Growth Rate | Job Increase (In Thousands) |
|---|---|---|---|---|
| | 1982 | 1995 | | |
| Engineering and Science Technicians | 1,243 | 1,661 | 33.6% | 418 |
| Health Technologists and Technicians | 627 | 898 | 43.2 | 271 |
| Other Technicians | 364 | 453 | 24.5 | 89 |
| Computer Specialists | 521 | 943 | 81.0 | 422 |
| Computer Operating Personnel | 580 | 737 | 27.1 | 157 |
| Computer Service Technicians | 55 | 108 | 96.4 | 53 |
| Engineering Equipment Mechanics | 83 | 94 | 13.3 | 11 |
| Instrument Repairers | 41 | 51 | 24.4 | 10 |
| Total | 3,514 | 4,945 | 40.7% | 1,431 |
| All Occupations | 101,510 | 127,110 | 25.2% | 25,600 |

Source: George Silvestri, et al., "Occupational Employment Projections Through 1995", Monthly Labor Review 106 (November 1983): 37-49, Table 1. The 1995 figures in this table are those assuming a moderate growth rate.

Table 5

ASSOCIATE DEGREES AND OTHER PRE-B.A. AWARDS
BY CURRICULUM, 1971-1982

| | 1970-1971 | 1974-1975 | 1978-1979 | 1981-1982 | Annual Growth 1971-1979 | Annual Growth 1979-1982 |
|---|---|---|---|---|---|---|
| Total, All Curricula | 307,880 | 458,532 | 515,371 | 560,694 | 6.65% | 2.8% |
| Arts and Science/General | 149,885 | 171,371 | 162,663 | 160,977 | 1.0 | -0.3 |
| Data Processing | 8,745 | 7,886 | 12,454 | 27,085 | 4.5 | 29.6 |
| Programmers | 2,149 | 2,344 | 4,122 | 10,026 | 8.5 | 34.5 |
| Operators | 387 | 571 | 927 | 1,214 | 11.5 | 9.4 |
| Health Services | 34,518 | 76,720 | 80,022 | 90,524 | 11.1 | 4.2 |
| Nursing | 22,116 | 45,913 | 50,880 | 52,511 | 11.0 | 1.1 |
| Radiologic, Surgical Optical Technologies | 1,463 | 4,586 | 6,082 | 5,627 | 19.5 | -2.5 |
| Mechanical/Engineering Technologies | 38,900 | 56,303 | 71,288 | 98,753 | 7.9 | 11.5 |
| Automotive and Diesel | 4,762 | 9,203 | 11,655 | 13,434 | 11.8 | 4.8 |
| Construction | 4,229 | 9,248 | 10,087 | 11,576 | 11.5 | 4.7 |
| Electronics | 7,851 | 10,834 | 14,613 | 25,181 | 8.1 | 19.9 |
| Other | 22,058 | 27,018 | 34,933 | 48,562 | 5.9 | 11.6 |
| Natural Science Technologies | 7,028 | 18,047 | 19,743 | 20,016 | 13.8 | 0.5 |
| Agriculture | 2,870 | 7,597 | 8,748 | 8,373 | 14.9 | -1.4 |
| Food Service | 693 | 2,620 | 3,789 | 4,520 | 23.7 | 6.1 |
| Business and Commerce | 51,037 | 82,987 | 121,261 | 129,881 | 11.4 | 2.3 |
| Public Services | 12,337 | 35,218 | 37,940 | 33,458 | 15.1 | -4.1 |

Source: National Center for Educational Statistics, Associate Degrees and Other Formal Awards Below the Baccalaureate, various years.

## The Supply of Students in High-Tech Vocational Education

An obvious question is whether the enthusiasm of students for high-tech vocational training matches the vigor of the national rhetoric. The best way to examine the supply of students in post-secondary vocational programs is to look at completers--the numbers of students who have received an Associate of Arts (A.A.) degree or some other formal award in pre-baccaluareate programs.[23] Table 5 presents data on completers for different curricula, between 1970-1971 and 1981-1982.

A remarkable shift in curricula has taken place recently. During the 1970s, the highest growth occurred in relatively conventional fields--in nursing and other low-tech components of health services (like dental assistants and hygienists); in some of the traditional curricula (like automotive and construction trades) within mechanical/engineering technologies; in agriculture and food service; in public services, which include programs for police, firefighters, and child care workers; and above all in business and commerce, which includes various managerial curricula as well as a large number of secretarial programs. Growth rates in high-tech programs--data processing, health technologies, electronics, and the "other" component of mechanical/engineering technologies that includes a variety of potentially high-tech occupations in instrumentation and other engineering-related fields--were modest but not overwhelming, relative to overall growth rates in community colleges. During this period annual growth rates of 6.7% in A.A. degrees were considerably higher than the growth rates of employment--which averaged 2.4% annually between 1971 and 1979. Enrollment in arts and science programs was essentially stable, representing 49% of completers in 1971 but only 32% eight years later, a clear indication of the long-run shift towards vocational programs.

Since 1979, high-tech programs have dominated the growth of community colleges. There has been an upsurge in demand for computer-oriented and other high-tech programs, reflected in both anecdotal evidence[24] and data on completers. Enrollments in data processing, in electronics, and in the "other" component of mechanical/engineering technologies grew much more

rapidly than other areas; in fact, growth in these areas accounts for more than the total growth of completers. In contrast, growth in business and commerce, health services, and natural science technologies tapered off, and completers in public service actually declined (as did liberal arts graduates). To be sure, programs that might be considered high tech remain a small fraction of the total: data processing, health technologies, and the potentially high-tech mechanical and engineering technologies account for only 19% of total completers, up from 13% a decade earlier. Thus, we see a pattern within the community colleges similar to occupational patterns as a whole: while high-tech programs have high growth rates, the numbers involved are still relatively small compared to the larger numbers of students in more conventional programs like business, public service, nursing, and liberal arts.

One question from these figures is whether the growth rates in high-tech vocational programs will be sustained. If so, then there is a possibility for post-secondary high-tech programs to follow the high school vocational pattern of "training for unemployment". The growth rate in data processing of 29.6% annually compares with a projected growth rate for computer specialists of 4.7% per year between 1982 and 1995; the growth rate of 14.3% among mechanical and engineering technologists compares with a growth rate of 2.1% among related technicians.[25] Perhaps more relevant is the fact that in many middle-level high tech occupations, the average number of openings--including those due to replacement needs as well as growth--are smaller than the number of community college graduates in related fields. The average number of openings between 1978 and 1990 for computer programmers is estimated to be 29,600, many of them at the B.A. level and over, while community colleges alone graduated about 10,000 in 1981-1982; 16,600 computer specialists are needed per year, while 27,000 graduated from community colleges; 70,900 technicians (excluding health technicians) are needed, while almost 74,000 technicians (excluding automotive and construction technicians) graduated.[26] While it is difficult to match occupations and programs of study precisely, these figures suggest that the numbers of community college graduates in high tech fields may now exceed openings, and that the upward trend in high-tech enrollments could only exacerbate these differences.

If growth rates and numbers of graduates in high-tech programs are higher than in high tech positions--as happened for more conventional curricula during the 1970s[27]--there are several possible outcomes. One is that the "middle-level" high-tech occupations are now going through a cobweb cycle, of the sort that has affected the market for engineers, scientists, and other higher-level personnel.[28] If so, then any tendency for over-enrollments is only temporary, as equilibrium between demand and supply will be re-established once an over-supply materializes, drives down returns to A.A. degrees, and causes fewer students to enroll. However, there is other evidence to suggest that the mechanisms driving demand and supply to an equilibrium may be weak in the community colleges. The information available to students seems to be relatively scant, and the manpower forecasting programs that might allow educators to adjust supply to changing demand conditions are erratic at best. The current infatuation with high tech seems to be generating new programs without much thought to their long-run employment opportunities, as if supply can create its own demand. (This is particularly true of educators trying to use high-tech education as a way to revitalize declining regions.) Finally, students in community colleges seem to respond more to costs than to benefits, implying that the effects of earnings differentials may not be strong enough to equilibrate supply and demand.[29] The history of high school voc ed provides little comfort: it has always been easier to create programs than to reduce or eliminate those that are worthless, and the result has been the prolongation of programs that have outlived any usefulness they might have had.

A second possibility is that a higher fraction of employees in middle-level occupations will have post-secondary vocational training, rather than any other kind of preparation. This may happen in several ways. Community college students may be absored into jobs in place of those with less preparation--a process we can describe either as "skills upgrading" or, more cynically, as credential inflation. Alternatively, they may take the places of those with more training, the process of de-skilling. Indeed, community colleges are ideally placed to benefit from the simultaneous processes of educational inflation--particularly given the failures of high schools--and de-skilling from professional-level positions.

Still a third reason why community college training may come to dominate other forms of preparation is the process of substitution, in which students shift from essentially equivalent programs into community college programs that are cheaper for either employers or for students because of public subsidies. This process of substitution has taken place in nursing, for example, where the fraction of graduating nurses with diplomas from hospital programs has fallen while the proportion with A.A. degrees has increased correspondingly.[30] Because of public subsidies and proximity, community colleges enjoy the advantage of lower cost compared to the alternative forms of training. The effort to socialize training costs--to shift costs from private to public sources, as has happened with nursing programs and with customized training--provides another reason for substitution.

It is too early to say what patterns high tech enrollments will follow, and which of the possible ways of absorbing increased graduates will materialize. However, the experiences of other vocational programs provide some warnings about potential problems for post-secondary programs, particularly in high-tech areas.

## Continuities with the Past

The shift of vocational education to the post-secondary level is relatively new, and the emergence of high-tech manufacturing--and the high hopes for its development--are also recent. Still, the current developments in vocational education for high-tech occupations are remarkably consistent with the history of vocational education throughout this century. From a historical viewpoint, these continuities should not be surprising: the development of micro-electronics and other new technologies are not necessarily more startling or disruptive than was the development of new machinery, factory organization, and steam-related technologies in the nineteenth century; the development of electrical machinery and new clerical and managerial occupations at the turn of this century was similarly the cause of great hopes, inordinate fears, and disruption in the schools. Within education, the challenges have been roughly the same since the turn of the century--to prepare students for labor markets, to provide both skill training and those attitudes conducive to productive work and to a particular form of

citizenship, and to negotiate between the pressures to use public schooling to equalize opportunities and the pressures to use the schools simply to replicate class patterns over generations. The constancy of technical change and of schooling role has generated a number of similarities over time.

Vocational education as panacea: An obvious similarity between the current burst of concern over education and earlier periods is the tendency to over-promise--to claim that educational reform can solve every social and economic problem. Vocational education has been especially prone to rhetorical inflation, especially in the claims that it can reduce unemployment and poverty, increase productivity and reduce inflation, and improve our international competitiveness. The language of the AACJC's call to arms, "Putting Americans Back to Work", is typical:

> Our nation is experiencing a sense of despair . . . that whatever we do will just not make much difference. Declining productivity, unemployment, and underemployment, stagflation and inflation, high interest rates, and federal deficits have become battering rams causing a staggering impact upon our nation. The mobilization of our human resources offers a way out . . . Our country desperately requires a bold new approach to human resource development. That new approach must be equivalent to the commitment that landed a man on the moon. Our "moon-shoot" for the 1980s must be aimed at the triple goals of ample employment opportunities, increased productivity, and economic health for the individual and the country.[31]

Advocates have also claimed that vocational education can resurrect depressed areas of the country, by attracting new industry (especially high-tech industry) in search of a trained labor force. In North Carolina, for example, the community college system is "the backbone of our economy . . . the single most important element in this program of economic development",[32] and the efforts to develop high-tech training programs as a way to lure high-tech industry to depressed areas--rather than setting up such programs after companies have moved into an area--are other examples of using vocational education in the desperate effort to replace declining conventional manufacturing with high-tech manufacturing.

These are consistent with a long history of claims that vocational

education can reduce unemployment, increase productivity, and stimulate international competition. The current preoccupation with besting Japan is similar to the concern at the turn of the century with competition from Germany, which at the time had a well-developed vocational education system that served as an inspiration for the American vocational education movement leading to the Smith-Hughes Act of 1917.[33] The problem with such claims is that they mistake the real sources of economic problems and promise more than vocational programs can possibly deliver. Increasing unemployment has been due more to the substitution of capital for labor, the export of jobs to other countries, and the rise of other countries, trends which vocational programs are powerless to change. Falling productivity has been due to myriad sources, like investment patterns and the shift away from manufacturing towards services and government employment,[34] none of which have anything to do with education policy. Our relative decline in international trade is due more to management errors in key sectors (like automobiles and steel) and to the maturation of countries that had previously been rebuilding from their destruction in World War II than it is to levels of education, in which the United States is still ahead of other countries. Similarly, the decline of regions within the United States and the shift from the North to the South is due to a number of forces--the decline of sectors like steel and automobiles, the search for lower labor costs and other costs of production, the effort to escape unions--that are beyond the scope of vocational programs to reverse. Not only are the economic development efforts through vocational programs zero-sum games--in that they can at best persuade a firm to locate in one region rather than another--but there is little evidence that they are effective.[35]

The most serious problem with over-promising is external to the schools: the claims that education and training can resolve much larger problems draws attention away from solutions that are more precisely addressed to causes. However, inflated rhetoric has also tended to prevent more careful analysis of which educational programs work and which merely depend on rhetoric for their justification. Such over-promising may also draw attention away from the more modest but certainly valuable role that vocational education can play in giving individuals real skills for those "middle-level" occupations that do

exist. Over the long run, the cycle of boom and bust--of inflated rhetoric followed by disappointment--often leads to political attack, like the criticisms that emerged during the 1970s of high school vocational education and Great Society programs.

The problem of keeping up: Vocational education has always been plagued with the problem of keeping up with changing production methods and techniques. The charicature of a high-school program, using outmoded equipment, instructors who have not practiced for decades, and methods that have passed from common practice, is part of the criticism that vocational education too often "trains for unemployment". The problem of keeping up with changing methods and materials is especially serious in high-tech areas, because hardware and software change so rapidly and because the costs of hardware are often high. In addition, skilled instructors are often difficult to obtain, because firms are able to pay much higher salaries than are community colleges.[36]

The dominant solution to the problem of keeping up has been to forge alliances with businesses, who can then supply equipment, materials, and sometimes instructors. Whether this solution can keep all high-tech vocational progams up to date is unclear, though it seems doubtful: there appear to be too many programs chasing too few generous firms for the "partnership" solution to work uniformly. However, even if this solution works, it exacerbates a different problem: the tendency for vocational education programs to offer specific rather than general training, in the sense of training tied to one company's equipment and methods.

Specific versus general training: Every evaluation of vocational education since the 1930s has complained that vocational programs provide too much specific training--training that prepares students for a narrow range of occupations, training that can easily become obsolete as occupations and sectors decline or methods change.[37] Yet the charge to make voc ed more general has never been successful, in part because what "general" vocational training might be has never been clear. Instead, educators have been driven towards more specific programs as a way of making their programs seem "relevant" and as a way of increasing placement rates.

Currently, several forces are pressuring post-secondary vocational programs towards specific training: the ubiquitous rhetoric of "partnership" between the public and the private sectors; the need for high tech programs to use equipment and instructors provided by specific firms, with the likelihood that firm-specific methods are taught; and the tendency within all parts of the community college to provide "customized training", programs designed to meet the needs of individual firms. Customized training apparently has something for everybody: it meets the needs of firms for certain kinds of training; the needs of community colleges to generate training programs that contribute to local economic development; and--since students in customized programs often find jobs in the firms for which training is done--the interests of students in employment and of community colleges in high placement rates.

However, there are several drawbacks to such partnerships between schools and firms, whether in the high-tech area or not. One is that, by design, students may be prepared for employment in a particular company, whether through skill training or through socialization to specific company norms; rather than being more broadly trained for a range of allied occupations or for a range of potential employers, a student's future is tied to one company. Second, a student may be narrowly trained to perform a small range of operations, rather than being more broadly training to understand the basic principles of a particular occupation or industry.[38] This again may make students vulnerable to changes in production methods, a problem that is especially serious in high-tech occupations with constant changes in equipment, software, and production procedures. Third, educators have encountered some pressure from business and industry to drop liberal requirements for the two-year degree and to concentate even more heavily on specifically-designed vocational programs, including programs of flexible length that vary from the traditional academic calendar.[39] Finally, the justification for public support of firm-specific training is unclear: in many cases, the development of "partnerships", especially in the form of customized training, looks like a way for businesses to fund their training at public expense. There may be a justification for public funding of general education, but for not the kind of specific training that has become so attractive to post-secondary programs.[40]

The problem of specific skill training may be especially acute in many applications of new technology. Paul Adler has argued that, whether the application of high technology increases or decreases the quantity of skills required, it changes the quality of skills. In particular, new technologies (and especially those based on microelectronics) increase the responsibility of the worker for production, in place of requiring only a "trained gorilla" responsible for rote manual labor; they demand an ability to perform more abstract rather than concrete tasks, since operations involving microelectronics cannot typically be seen and are not concrete in the old-fashioned ways of typewriters, paper output, and filing cabinets; and they require interdependence among jobs (and thus require some understanding of other jobs and encourage team work and job interchangeability) because computer-aided production processes are linked in complex networks, rather than being linked in the simple sequential process of the assembly line.[41]

If these changes in the kinds of skills required prove to be widespread, the most valuable skills in high-tech occupations may be the old-fashioned ones--the ability to think abstractly and symbolically, the ability to understand the underlying structure of interrelated production systems, the personal attributes of responsibility and independence--while specific skill training may be both insufficient and quickly obsolete. The need for such general skills is especially important because of the view, increasingly common, that community colleges are partly remedial institutions:[42] given the failure of high schools, the lack of general skill training in high-tech vocational programs will leave students bereft of the ability to understand the technical complexities they manipulate.

The egalitarian claims of vocational education: The community colleges have claimed for themselves the mantle of equal opportunity, particularly because of their open door policies. As Secretary of Education Terrel Bell declared, "perhaps the most important role [of community and technical colleges] is making post-secondary education accessible to so many who otherwise would have little or no opportunity beyond high school".[43] Typical of the rhetoric of post-secondary educators is the statement that "the community college is the best expression in higher education of the

egalitarian ideal of American life: by maintaining an open admissions policy the college fosters our belief in equality of opportunity".[44] Post-secondary institutions are heirs to a similar egalitarian claim made by vocational educators since the turn of the century: that vocational education provides an education to those who otherwise would get none, and that it provides a way of integrating into the economic mainstream those who would otherwise be left out, including women and minorities. Accompanying such rhetoric is a common assertion of moral parity with higher-level "academic" institutions: "We of the community colleges do not believe that there are higher and lower studies, arts that are liberal and arts that are servile--or that education for meaningful work is less worthy than education for meaningful citizenship".[45]

The claim that the community colleges represent the "best expression of the egalitarian ideal" rests on two assumptions: that those who attend community colleges would otherwise have received no further education; and that community college confers an economic advantage over those who do not attend. (A third possibility--that the community colleges are egalitarian because they provide a low-cost mechanism for individuals to progress to a B.A. degree--has been all but abandoned under the conversion of community colleges to terminal vocational institutions.) Both these propositions may be correct, though evidence for them is far from complete.

On the other hand, these egalitarian claims have been overstated. Within the system of higher education, community colleges represent the lowest "track" relative to four-year universities and colleges, with a higher proportion of working-class and minority students; the emergence of the community college has stratified the system of higher education by class and race, just as high school voc ed programs stratified the high school after 1900.[46] Specifically in the area of high tech programs, fears that minority students and women are less well prepared in science and math--and that middle-class students have a head start by having computers in their homes--have generated the suspicion that high-tech voc ed will foster the advancement only of white, male, and middle-class students. Others have expressed fears that the community college is becoming a middle-class institution, especially because of economic pressures.[47]

Some inequalities--especially the position of the community colleges as the lowest "track" within higher education--are caused by pressures external to the community college themselves. Others are more their fault, caused by divisions within post-secondary education. Community college programs are highly stratified by gender, with few women in trade and industrial programs, and few men in "female" areas like secretarial or health technician programs. While minorities tend to be relatively over-represented in community colleges, there is some evidence that blacks tend to be over-represented in the least rewarding programs.[48] Finally, the existing "partnerships" between business and education--including the "customized training" that has become so prominent--tend to be inegalitarian, for the simple reason that many of them take existing employees of firms and provide them additional training; the patterns of racial and gender discrimination that pervade business are thereby replicated in customized training programs as well.

In response to those who promote the egalitarian role of the community college and those who criticize its inequalities,[49] others have denied that equality should be a goal. As two prominent students of the community college declared,

> The real benefit of the community college cannot be measured by the extent to which it contributes to the overthrow of the social-class system in America. Nor can it be measured by the extent to which the college changes the mores of its community. It is a system for individuals, and it does what the best educational forms have always done: it helps individuals learn what they need to know to be effective, responsible members of their society.[50]

The confusion about the egalitarian achievements of post-secondary education and the debates over collective rather than individualistic values reflect a larger problem: the replication, in every corner of the education system, of the tension between egalitarian goals and the greater pressures to preserve inequalities through the operation of the schools.

The basic dilemma of vocational education has never been resolved: whether it provides greater opportunity by giving a chance for advancement to working class youth who would otherwise fail to continue in schools (the

egalitarian claim), or whether it thwarts advancement by preventing some students from continuing to higher levels of eduction (the "cooling out" notion). If some of each outcome occurs, then there may be enough evidence to sustain both ideas, though the overall effect of vocational programs may be simply to reduce the variation of educational outcomes.[51] The dilemma of what vocational education really does remains the same, whether the content of vocational programs involves new technologies or old.

## The Vocational Imperative

Vocational education for high-tech occupations provides genuine opportunities. These occupations require some real skills,[52] not just appropriate attitudes; the necessary skills include both "academic" components--especially knowledge of science and math, and some capacities for abstraction--as well as more "vocational" components related to manipulative skills and experience, a combination that suits vocational education in school settings perfectly. Post-secondary programs often train older students (rather than teenagers), students who are old enough to enter the "adult" labor market, students who have a better chance of knowing what they want to do and being well motivated. These programs also have the flexibility that has by now vanished from high schools and four-year institutions, and community colleges can adjust programs to suit the technical requirements of different occupations. The demand for middle-level high-tech occupations is real enough (even though demand has often been overstated), and the pay and working conditions of these jobs are certainly better than the semi-skilled assembler and service occupations lower in the occupational structure. Preparing students for these positions constitutes a job worth doing well--perhaps a job without the glamor and the status of preparing researchers on the frontiers of artificial intelligence, but still a job crucial to the well-being of firms and workers alike.

Still, at the very moment that high tech has come to national preoccupation, we can see the glimmers of potential problems, similar to those of vocational education in the past. One of these is the tendency towards exaggertion, overstating how many high-tech jobs will be available, and over-promising what vocational education can do to solve the country's problems.

In turn, this can lead all too easily to preparing too many students for too few jobs, or training students for jobs that need little preparation except brief on-the-job training. Another is the tendency to fall into too-specific training, under pressure to be "relevant" and to establish "partnerships". Particularly in the high-tech area, the tendency towards specific skills is inappropriate because the dominant complaint is that many students lack the general skills in science and math that are prerequisites for further learning, and because the pace of change more quickly makes specific skills obsolete. A final problem is a confusion about the egalitarian role of vocational education, generated by the dissonance between rhetoric and reality: at the same time that post-secondary schools claim for themselves the fulfillment of equal educational opportunity, they often operate to perpetuate old, familiar patterns of inequality.

The bandwagon effect in education is understandable, but its effects have always been ambiguous. Whenever it has appeared in the post-war period--in the Sputnik crisis of 1957, and the more recent crisis of confidence in the high school; in the discovery of compensatory education in the 1960s, and the school finance reforms of the 1970s; in the cries of undergraduates for "relevance" in the 1960s, and the cries for "relevance" (of a different sort) of undergraduates in the 1970s and 1980s; in the promise that schools can improve our competitiveness with Russia or with Japan, or contend with "social dynamite" in urban slums or with youth unemployent, or respond to the technological unemployment of the 1960s or the high-tech challenge of the 1980s--the results often have a similar cast. An excess of enthusiasm overstates the problem, underestimates the solutions, and leaves the essential structure of the schools unchanged after public attention has waned. The residues that remain--of which compensatory education is a good example--are often valuable, but just as often the fires of enthusiasm burn for nothing.

In the case of high tech vocational education, much larger forces drive the reactions of educators, students, businesses, and social commentators calling for a renewal of our "human resources". The vocational imperative is hard to resist: it gains support from students in search of jobs, businesses in search of trained workers, and educators in search of students, and it

gives education an economic and social function larger than the training of students for a few vacancies. Beyond that, the power of vocationalism has been its ability to serve several contradictory roles of education simultaneously: the need to serve the interests of individual students while trying to address more collective goals; the duty to prepare students for a highly differentiated set of occupations while still passing on a common core of knowledge and values; the pressure to provide equality of educational opportunity within an unequal society where the pressures to reproduce inequality have been even greater; the need to use public resources in support of democratic goals, and the pressure from capital to use public resources for private ends; the need to serve simultaneously the "hand" and the "mind", the practical and the abstract, the vocational and the academic.

There is almost no constituency to resist vocationalism. Some educators try occasionally, complaining that the ability to reason is disappearing under the weight of vocational impediments, but they can be dismissed as academic and irrelevant. Some business people complain occasionally that their employees don't know the basics, but they often play a role in the use of educational credentials that is a part of vocationalism. The "back to basics" movement has periodically appeared in different forms, but this movement has concerned itself more with the "frills" of education and its egalitarian goals than with its vocational purposes. So too in the community colleges there have been opponents of its increasingly vocational role and proponents of a greater role for general education,[53] but they have been branded elitists, seekers of a false academic status, or barriers to growth; essentially they--like educators at all other levels of education--have no general conception of the role of schooling to offer in place of vocationalism.

The short-run appeal of vocationalism is irresistable, but the long-run consequences are poor: educational inflation, as students are driven to attend school longer to gain an advantage in the job market; the dilution of skill training and the degradation of learning, and their replacement with the search for credentials; heightened battles over access to education, while educational inequalities are replicated in new forms; unending battles between teachers and students, contributing to the sense of schools as unpleasant

places; an increasingly irrational relationship between schooling and labor markets, even though vocationalism was always intended to establish a closer relationship between schooling and work. The power of vocationalism is a manifestation of the ability of capitalism to bend institutions to its end, but to do so in a way that is collectively irrational, in a way that makes these institutions less useful in the long run.

The emergence of new vocational challenges--like the appearance of new technologies--begins this cycle all over again. The outcome could be very different, and it still may be possible for post-secondary vocational education to avoid the pitfalls of the past. To do that, however, may require a different conception of schooling.

Footnotes

1. For a good review of the "optimist" and "pessimist" positions on technology, see Paul Attewell, "Microelectronics and Employment: A Review of the Debate", University of California, Santa Cruz, April 1983.

2. Henry Perkinson, The Imperfect Panacea: American Faith in Education, 1865-1965, (New York: Random House, 1968).

3. These figures are taken from the Vocational Educational Data System (VEDS), in National Center for Education Statistics, "Vocational Education Enrollment Remains Steady", December 1982. These data are difficult to compare with earlier enrollment data because of changes in methods of collection and definitions. For criticisms of the VEDS data, see Robert Barnes, "Ten Years of Federal Statistics on Vocational Education, U.S. Department of Education", April, 1984.

4. However, the evidence on returns to post-secondary vocational programs is still not extensive. Among other evaluations of secondary-level vocational education, see John Grasso and John Shea, Vocational Education and Training: Impact on Youth, (Berkeley: Carnegie Council on Policy Studies in Higher Education, 1979); Beatrice Reubens, "Education for All in High School?" in James O'Toole, ed., Work and the Quality of Life, (Cambridge: MIT Press, 1974); The Vocational Education Study: The Final Report, Vocational Education Study Publication No. 8, (Washington, D.C.: National Institute of Education, September 1981), Chapter 7; for some limited positive evidence, see Thomas Daymont and Russell Rumberger, "The Impact of High School Curriculum on the Earnings and Employability of Youth", in R. Taylor, H. Rosen, and F. Pratzner, eds., Job Training for Youth (Columbus: National Center for Research in Vocational Education, 1982). For evidence on post-secondary programs, see David Breneman and Susan Nelson, Financing Community Colleges: An Economic Perspective, (Washington, D.C.: The Brookings Institution, 1981); Larry Blair, Michael Finn, and Wayne Stevenson, "The Returns to the Associate Degrees for Technicians", Journal of Human Resources 16 (Summer 1981): 449-458; Harry Heinemann and Edward Sussna, "The Economic Benefits of a Community College Education", Industrial Relations 10 (October 1970): 345-354; Wellford Wilms, Public and Proprietary Vocational Training: A Study of Effectiveness, (Berkeley: Center for Research and Development in Higher Education, 1974); Wellford Wilms and Stephen Hansell, "The Dubious Promise of Post-Secondary Vocational Education: Its Payoff to Dropouts and Graduates in the U.S.A.", International Journal of Educational Development 2 (Spring 1982): 43-59; Fred Pincus, "The False Promise of Community Colleges: Class Conflict and Vocational Education", Harvard Educational Review 50, (August 1980): 332-361.

5. Data on enrollments come from the National Center for Educational Statistics, Fall Enrollments in Higher Education, various years.

6. On the shift to vocational programs and debates over academic versus vocational goals, see L. Stephen Zwerling, Second Best: The Crisis of the Community College (New York: McGraw Hill, 1976); Steven Brint and Jerome Karabel, "The Transformation of the Two-Year Colleges: From Liberal Arts to

Vocational Training", Huron Institute, Cambridge, September 1980; Pincus, op. cit.

7. Between 1965 and 1976 the proportion of two-year college students in vocational program increased from 13% to 50%; see American Association of Community and Junior Colleges, Types of Programs Offered in Two-Year Colleges (Washington, D.C.: AACJC). In 1978-1979, when total community college enrollments were 4,064,382, vocational enrollments in A.A. programs were 1,949,558 and enrollments in long-term adult programs--largely technical institutes--were 969,560 suggesting that as much as 72% of enrollments were vocational; see the National Center for Educational Statistics, The Condition of Vocational Education (Washington, D.C.: U.S. Government Printing Office, 1981), Table 3.2. These data are difficult to interpret because of ambiguity in what short-term and long-term adult programs include; thus, the VEDS data and the fall enrollment figures may not be compatible. At the same time, another 3,805,071 students were in "adult" vocational courses shorter than six months--many of these in non-degree programs within the community colleges. The shift toward vocational goals has also influenced degree recipients, as the data in Table 5 shows; in 1970-1971, 51% of all A.A. degrees and other awards below the B.A. level were in occupational curricula (rather than arts and sciences and other general program); by 1981-1982 this fraction had grown to 71%.

8. The parallels have been discussed in Martin Trow, "The Second Transformation of American Secondary Education", International Journal of Comparative Sociology 2 (1961): 144-165; Jerome Karabel, "Community Colleges and Social Stratification: Submerged Class Conflict in American Higher Education", Harvard Educational Review 42 (November 1972): 521-562; and Marvin Lazerson and W. Norton Grubb, American Education and Vocationalism: A Documentary History, 1870-1970 (New York: Teachers College Press, 1974).

9. James Mahoney, "Big Boom in Energy Programs", Community and Junior College Journal 52 (September 1982): 32-36.

10. Marion Rice, "College, Industry Join for Robotics Planning", Community and Junior College Journal 53 (April 1983) 47.

11. Mark Winter, "IVCC's Quantum Leap", Community and Junior College Journal 54 (November 1984) 43.

12. Dale Parnell, "Putting America Back to Work: Community, Technical, Junior Colleges Ready", Community and Junior College Journal 53 (September 1982): 12.

13. M. Ross Bagle, "College/Business Marriage: Sensible Response to Hard Times", Community and Junior College Journal 54 (November 1983): 15-17.

14. Richard Wilson and Dwight Davis, "Putting the Nation on Notice", Community and Junior College Journal 52 (April 1982): 6-8.

15. Don Garrison and Andrew Korin, "Toward a National Policy for Human Resource Development and Econonic Renewal", Community and Junior College Journal 52 (April 1982): 9-11.

16. On the "partnerships" with business and industry, see for example, Wilson and Davis, op. cit.; Bayle, op. cit.; Ronald Watchke, "Partnership Vital to High Technology", In Community and Junior College Journal 53, (December 1982/January 1983): 28-52; Catharine Warmbrod, Jon Persavick, and David L'Angelle, Sharing Resources: Post-Secondary Education and Industry Cooperation (Columbus, Ohio: National Center for Research in Vocational Education, 1981); Dale Parnell and Roger Yarrington, Proven Partners: Business, Labor, and Community Colleges (Washington, D.C.: AACJC, 1982); Harold Hodgkinson, "Establishing Alliances with Business and Industry", in George Vaughan and Associates, Issues for Community College Leaders in a New Era (San Francisco: Jossey-Bass, 1983).

17. On the conventional view, see Pincus, op. cit.; N.C. Harris and J.F. Grede, Career Education in Community Colleges (San Francisco: Jossey-Bass, 1977), especially Chapter 3; Fred Pincus, "Class Conflict and Community Colleges: Vocational Education During the Reagan Years", forthcoming, Review and Proceedings of the Community College Humanities Association.

18. C. R. Monroe, Profile of the Community College (San Francisco: Jossey-Bass, 1972), p. 82.

19. Attewell, op. cit., provides a good synopsis of these positions.

20. The results in this section are preliminary findings from a larger study of the high technology sector in Texas and other states; see John Campbell and Susan Goodman, High Technology Employment in Texas: A Labor Market Profile (Austin: Bureau of Business Research, The University of Texas at Austin, in process). The definition of high-technology sectors they use is the "Massachusetts" definition, taken from High Technology Employment in Massachusetts and Selected States (Boston: Massachusetts Division of Employment Security, March 1981). The sectors considered high tech include those listed in Table 2 plus guided missles and space vehicles.

21. Of course, it is possible that the Texas experience is not typical of the rest of the country, particularly if Texas is now in an early "development" stage of its high-tech industry, rather than a more mature stage like California, Massachusetts, or North Carolina. On the other hand, one could argue that the Texas experience is more typical of the rest of the country, and that the experience of the "pioneers" is atypical. These arguments cannot be resolved without further empirical work.

22. Others who have made this argument include Henry Levin and Russell Rumberger, "The Educational Implications of High Technology", Project Report No. 83-A4, Institute for Research on Educational Finance and Governance, Stanford University, February 1983; Donald Tonaskovic-Devey and S. M. Miller, "Can High-Tech Provide the Jobs?", Challenge, May-June 1983; Richard Riche, Daniel

Hecker, and John Burgan, "High-Technology Today and Tomorrow: A Small Slice of the Employment Pie", Monthly Labor Review 106 (November 1983): 50-58.

23. There are three ways to examine students in community colleges: through N.C.E.S. data on fall enrollments, through the data on A.A. degrees and other formal awards, or through the VEDS data on enrollments on vocational programs. Most attention has focused on total enrollment, because the numbers of enrollees have become so high. The only data on enrollment by area of training comes from the VEDS sytem, which is unreliable and inconsistent; see Barnes, op. cit.. On the other hand, data on degrees has been consistently collected over a long period, and so these data are of much higher quality. In addition, there is an extraordinarily high drop-out rate from community colleges; enrollment patterns are not necessarily indicative of the real training that takes place, which may be better measured by degrees completed. Enrollment data may include a large number of students who enroll casually, without adequate information or concrete plans, and who are likely to drop out without acquiring significant skills. If students enter programs where occupational demand is weak and then drop out at a greater rate than students in programs where demand is strong, then patterns of completers will be more closely related to demand than are enrollment patterns. This is close to what we see in available data, where the relationship between enrollment and demand varies wildly while the relationship between degrees received and employment is much more regular. See W. Norton Grubb, "Occupational Demand and the Rise of Post-secondary Vocational Education", Institute for Research on Educational Finance and Governance, Stanford University, Report No. 83-A9, May 1983.

24. See Elizabeth Useem, "Education and High Technology Industry: The Case of Silicon Valley", University of Massachusetts at Boston, August 1981.

25. These figures use the moderate projections; see George Silvestri, John Lukosiewicz, and Marcus Einstein, "Occupational Employment Projections through 1995", Monthly Labor Review (November, 1983), Table 1.

26. Data on annual openings come from The National Industry-Occupation Employment Matrix 1970, 1978, and Project 1990, Vol. II, Bureau of Labor Statistics, Bulletin 2086, April 1981, Table 5.

27. Grubb, op. cit.

28. On cobweb cycles in professional occupations, see for example Richard Freeman, The Market for College-Trained Manpower (Cambridge: Harvard University Press, 1971).

29. On the lack of information available and of manpower foerecasting, see Harold Starr, "Vocational Education's Response to Skilled Industrial Worker Shortages", in Robert Taylor, Howard Rosen, and Frank Pratzner, eds., Responsiveness of Training Institutions to Changing Labor Market Demands (Columbus: National Center for Research in Vocational Education, 1983); W. Norton Grubb, Robert Glover, et al., The Persistent Dilemmas of Preparing

for Work: Occupational Training Programs in Texas (Austin: L.B.J. School of Public Affairs, 1983), Chapter 2.

The literature on higher education enrollments indicates that lower income (or lower SES) students are more sensitive to prices (tuition) and to unemployment rates and wages of unskilled workers (as measures of opportunity costs) than are higher income students. The evidence on responses to earnings differentials is much more sparse, though some results indicate that these responses are small. These findings suggest that community college students may react more to direct and opportunity costs than to the benefits of college in increasing earnings.

30. This example is cited in Pincus, op. cit. For a fuller examination of different explanations of rising community college enrollments and completions, see Grubb, op. cit.

31. Parnell, op. cit., p. 12.

32. Drake Campbell and D. M. Faircloth, "State Models for Economic Development", Community and Junior College Journal 52 (April 1982), 18-19.

33. On the history of these claims, see Lazerson and Grubb, op. cit.; W. Norton Grubb, "The Phoenix of Vocationalism: Hope Deferred is Hope Denied", New Directions in Education and Work 1 (Spring 1978).

34. Lester Thurow, "Death by a Thousand Cuts", New York Review of Books, December 17, 1981.

35. For reviews of the large literature on incentives for location, see Michael Barker (ed.), State Taxation Policy (Durham, North Carolina: Duke University Press, 1983); Advisory Commission on Intergovernmental Relations, Regional Growth: Interstate Tax Competition (Washington, D.C.: ACIR, March 1981); Roger Vaughan, The Urban Impacts of Federal Policies, Vol. 2: Economic Development, RAND Report R-2028-KF/RC, July 1977.

36. See the articles on education-business partnerships in footnote 16 above; see also Useem, op. cit, and Grubb, Glover, et al., op. cit.

37. Grubb, "The Phoenix of Vocationalism", op. cit.

38. For this criticism of customized training, see also Stuart Rosenfeld, "The New Shape-up: Schooling Workers to Stay in Line", The Progressive, April 1982.

39. Elizabeth Useem, "Education and High Technology Industry: The Case of Silicon Valley", August 1981, pp 15-16.

40. On the human capital model of specific and general training and the justifications for public funding, see Gary Becker, Human Capital, Second Edition (New York: National Bureau of Economic Research, 1975), Chapter II.

41. Paul Adler, "Rethinking the Skill Requirements of New Technologies", Harvard Business School, October 1983.

42. On the remedial function, see Arthur Cohen and Florence Brawer, The American Community College (San Francisco: Jossey-Bass, 1982), Chapter 9; Donald Barshis and Thomas Guskey, "Providing Remedial Education", in George Vaughan and Associates, Issues for Community College Leaders in a New Era (San Francisco: Jossey-Bass, 1983).

43. "AACJC President's Column: An Interview with Secretary Terrel Bell", Community and Junior College Journal 52 (December 1981/January 1982): 2-4.

44. William Vincent, "In Support of Open Admissions", Community and Junior College Journal 52 (Decdember 1981/January 1982): 12-14.

45. Seymour Eskow, "Putting Americans Back to Work: Phase II", Community and Junior College Journal 54 (November 1983): 12-14.

46. Karabel, op. cit.; Pincus, op. cit.

47. Robert G. Templin, Jr., "Keeping the Door Open for Disadvantaged Students", in George Vaughan and Associates, Issues for Community College Leaders in a New Era (San Francisco: Jossey-Bass, 1983).

48. On patterns of crowding by gender and race, see "Descriptive Study of the Distribution of Federal, State, and Local Funds for Vocational Education", Project on National Vocational Education Resources, University of California, Berkeley, September 1981, Chapter 7. These results may not be reliable because they are based on the VEDS data, criticized in Barnes, op. cit..

49. The issue of equality of access has generated a debate within community college circles, between those "egalitarians" who want to maintain an open-door policy and the "elitists" who want to restrict admissions in order to increase the likelihood of completion, increase the overall equality of education, and maintain a balance between vocational and more academic courses. See the debate on "Transfer and Attrition" in the Community and Junior College Journal 52 (December 1981/Janury 1982): 17-23; William Shawl, "Are We Collegiate?", Community and Junior College Journal 53 (November 1982): 11.

50. Cohen and Brawer, op. cit., p. 356.

51. That is, the existence of post-secondary programs may increase schooling for

some high-school gradutes who would otherwise not have continued past high school, and may decrease schooling for graduates who would otherwise have gone to four-year colleges and completed a B.A. if both these outcomes are substantial, then the variance of schooling falls without necessarily changing the average level of schooling. These outcomes have never been empirically examined, however.

52. Even this may not be uniformly true; for evidence that many employers value post-secondary education--even in technician programs--as socialization mechanisms rather than skill training see Wellford Wilms, "The Limited Utility of Vocational Education: California Employers' Views", Public Affairs Report 24 (August 1983), University of California at Berkeley.

53. On opposition to vocational goals, see Brint nd Karavel, op. cit. On the need for general education in community colleges, see Chester Case, "Reformulating General Education Programs", in George Vaughan and Associates, op. cit.